

The Milky Way is warped

February 4 2019



Artist's impression of the warped and twisted Milky Way disk. Credit: CHEN Xiaodian

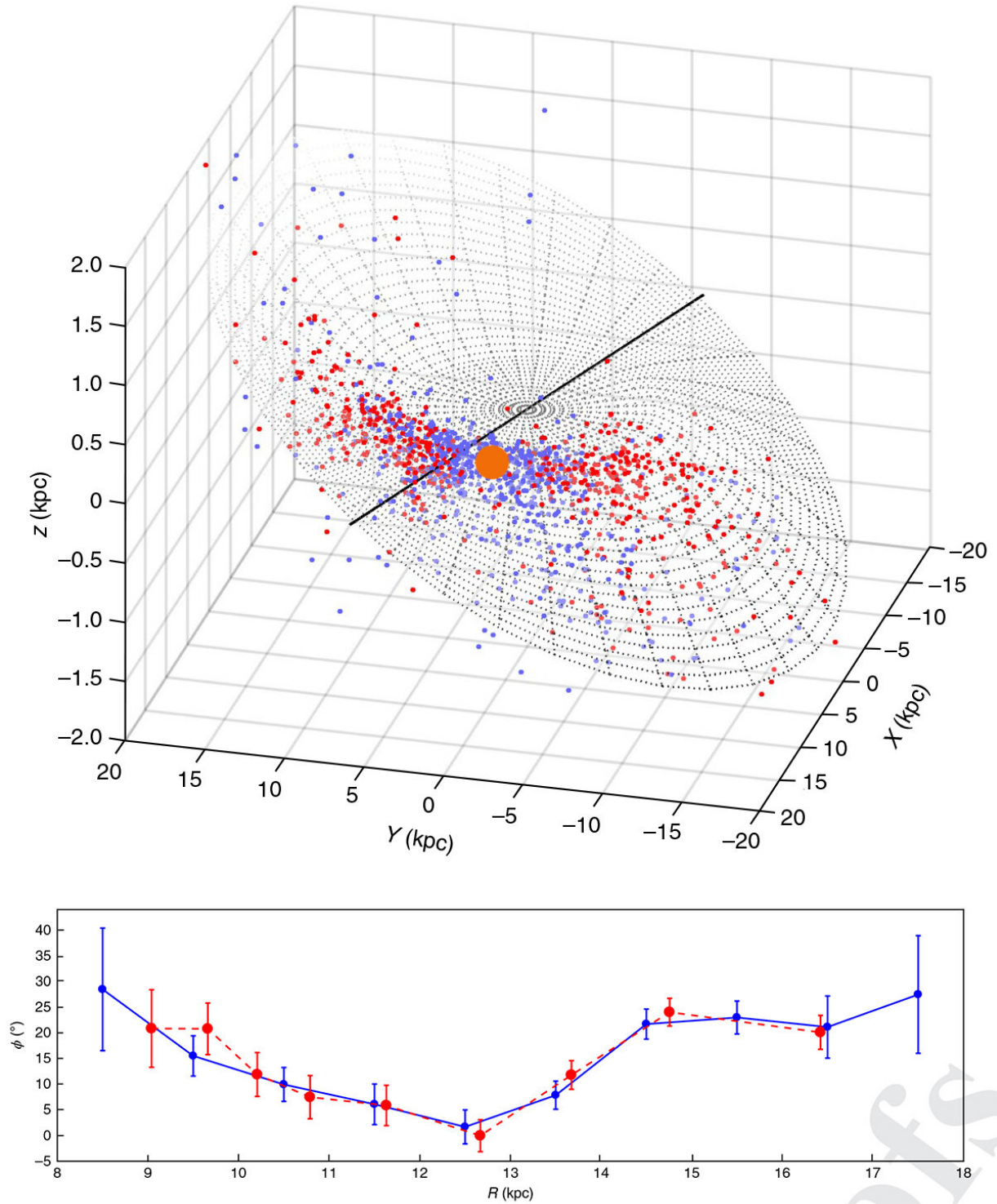
The Milky Way galaxy's disk of stars is anything but stable and flat. Instead, it becomes increasingly warped and twisted far away from the Milky Way's center, according to astronomers from National Astronomical Observatories of Chinese Academy of Sciences (NAOC).

From a great distance, the galaxy would look like a thin disk of stars that orbit once every few hundred million years around its central region, where hundreds of billions of stars, together with a huge mass of dark matter, provide the gravitational 'glue' to hold it all together.

But the pull of gravity becomes weaker far away from the Milky Way's inner regions. In the galaxy's far outer disk, the [hydrogen atoms](#) making up most of the Milky Way's gas disk are no longer confined to a thin plane, but they give the disk an S-like warped appearance.

"It is notoriously difficult to determine distances from the sun to parts of the Milky Way's outer gas disk without having a clear idea of what that disk actually looks like," says Dr. Chen Xiaodian, a researcher at NAOC and lead author of the article published in *Nature Astronomy* on Feb. 4.

"However, we recently published a new catalogue of well-behaved [variable stars](#) known as classical Cepheids, for which distances as accurate as 3 to 5 percent can be determined." That database allowed the team to develop the first accurate three-dimensional picture of the Milky Way out to its far outer regions.



Top: 3D distribution of the classical Cepheids in the Milky Way's warped disk.
 Bottom: Precession of the warp's line of nodes with Galactocentric radius.
 Credit: CHEN Xiaodian

Classical Cepheids are [young stars](#) that are some four to 20 times as massive as the sun and up to 100,000 times as bright. Such high [stellar masses](#) imply that they live fast and die young, burning through their nuclear fuel very quickly, sometimes in only a few million years. They show day- to month-long pulsations, which are observed as changes in their brightness. Combined with a Cepheid's observed brightness, its pulsation period can be used to obtain a highly reliable distance.

"Somewhat to our surprise, we found that in 3-D, our collection of 1339 Cepheid [stars](#) and the Milky Way's gas disk follow each other closely. This offers new insights into the formation of our home galaxy," says Prof. Richard de Grijs from Macquarie University in Sydney, Australia, and senior co-author of the paper. "Perhaps more importantly, in the Milky Way's outer regions, we found that the S-like stellar disk is warped in a progressively twisted spiral pattern."

This reminded the team of earlier observations of a dozen other galaxies which also showed such progressively twisted spiral patterns.

"Combining our results with those other observations, we concluded that the Milky Way's warped spiral pattern is most likely caused by torques—or rotational forcing—by the massive inner disk," says Dr. LIU Chao, senior researcher and co-author of the paper.

"This new morphology provides a crucial updated map for studies of our galaxy's stellar motions and the origins of the Milky Way's disk," says Dr. DENG Licai, senior researcher at NAOC and co-author of the paper.

More information: An intuitive 3D map of the Galactic warp's precession traced by classical Cepheids, *Nature Astronomy* (2019). [DOI: 10.1038/s41550-018-0686-7](https://doi.org/10.1038/s41550-018-0686-7) , www.nature.com/articles/s41550-018-0686-7

Provided by Chinese Academy of Sciences

Citation: The Milky Way is warped (2019, February 4) retrieved 1 May 2024 from
<https://phys.org/news/2019-02-milky-warped.html>

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